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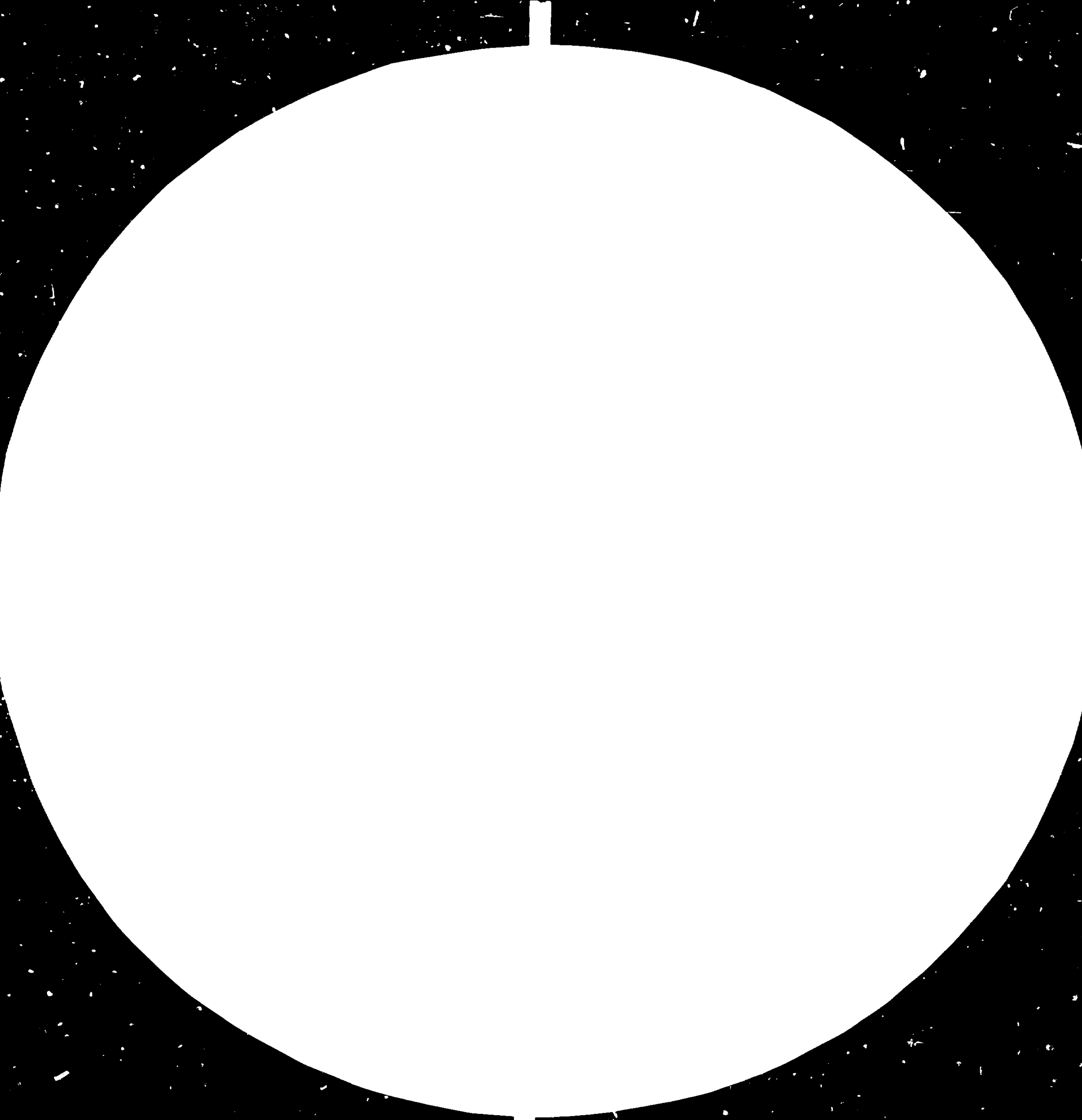

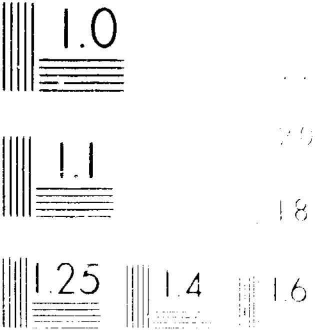
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RESTRICTED

ASSISTANCE TO THE SNAI SUGAR PLANT AT JOWHAR

SI/SOM/79/804

SOMALI DEMOCRATIC REPUBLIC

Terminal report

Prepared for the Somali Democratic Republic
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of V. Guruswamy,
cane-sugar industry technologist

United Nations Industrial Development Organization
Vienna

80-40355

Explanatory notes

The monetary unit in the Somali Democratic Republic is the Somali shilling (SoSh). During the period covered by the report, the value of the Somali shilling in relation to the United States dollar was $US 1 = SoSh 6.295.

A slash between dates (e.g., 1970/71) indicates a crop year, financial year or academic year.

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

References to "tons" are to metric tons, unless otherwise specified.

The following abbreviations of organizations are used in this report:

FAO	Food and Agriculture Organization of the United Nations
SNAI	Societa Nazionale Agricola Industriale
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization

The following technical terms and abbreviations are used in this report:

bagacillo	also known as cush cush, fine particles of bagasse
bagasse	fibrous residue of sugar cane
Bx	Brix measure of sugar concentration by weight
cuitometer	instrument for measuring conductivity
massecuite	a dense mass of sugar crystals mixed with mother liquor
pH	measure of acidity/alkalinity on a scale 0-14
pol	polarization (percentage measure of sugar content present)
rotameter	gauge for measuring the flow of a liquid or gas
spotter	device for moving a freight car into position for loading or unloading

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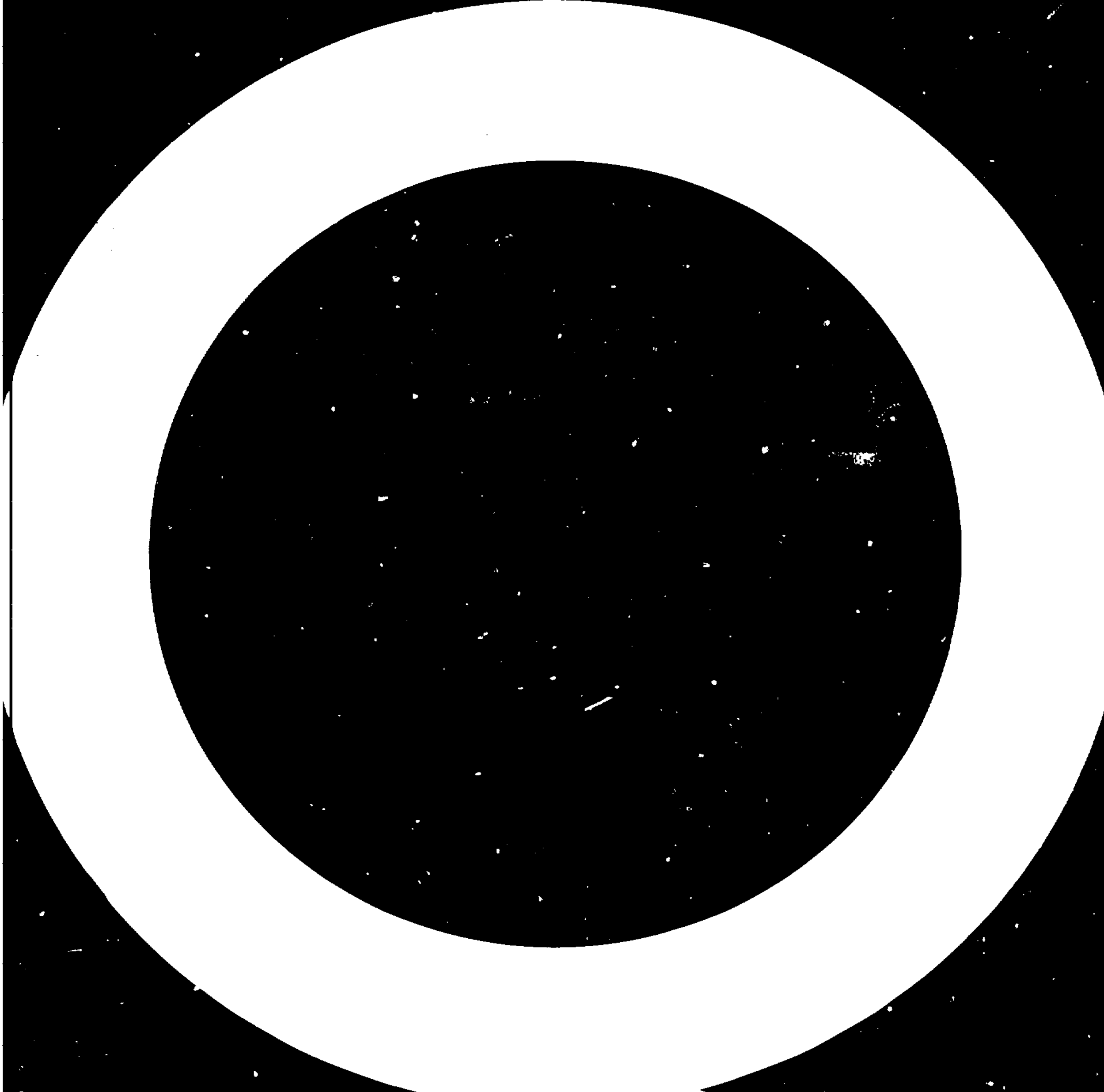
ABSTRACT

This project, "Assistance to the SNAI sugar plant at Jowhar" (SI/SOM/79/804), was carried out for the Government of the Somali Democratic Republic by an expert of the United Nations Industrial Development Organization (UNIDO) acting as executing agency for the United Nations Development Programme (UNDP).

The purpose of this project was to advise the Government on increasing the production of cane sugar to meet domestic demand, and on improving the technical operation of the sugar plant at Jowhar to achieve a better utilization of its installed capacity.

A previous UNIDO project entitled "Rehabilitation and improvement programme for the SNAI sugar plant" was carried out in 1977 and the intention of the present mission was to assist the Government in implementing this rehabilitation and improvement programme. The expert was first sent out for a three-month mission within the project RP/SOM/78/006 and his assignment was then extended for a further nine months under the present project. This report covers the expert's work in the SNAI sugar plant for a year from 6 April 1979 to 5 April 1980.

During this time, the expert studied the workings of the sugar plant both during the production seasons and during the maintenance periods in between. He made detailed recommendations to the management of the factory on modifications to equipment and production processes. In this report, recommendations are given for the implementation of a complete rehabilitation and improvement programme for the factory. The recommendations are divided into those for immediate improvements which can be carried out with existing personnel and local resources, those covering a longer-term complete modernization of the factory requiring imported equipment and machinery, and recommendations for training of personnel.



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INTRODUCTION

This project, "Assistance to the SNAI sugar plant at Jowhar" (SI/SOM/79/804), was carried out for the Government of the Somali Democratic Republic by an expert of the United Nations Industrial Development Organization (UNIDO) acting as executing agency for the United Nations Development Programme (UNDP).

The purpose of this project was to advise the Government on increasing the production of cane sugar to meet domestic demand, and on improving the technical operation of the sugar plant at Jowhar to achieve a better utilization of its installed capacity. Details of the expert's duties are given in the job description in annex I.

A previous UNIDO project entitled "Rehabilitation and improvement programme for the SNAI sugar plant" was carried out in 1977, and the intention of the present mission was to assist the Government in implementing this rehabilitation and improvement programme. The expert was first sent out for a three-month mission within the project RP/SOM/78/006 and his assignment was then extended for a further nine months under the present project. This report covers the expert's work in the SNAI sugar plant for a year from 6 April 1979 to 5 April 1980.

During this time, the expert made detailed recommendations on modifications to the plant's machinery and production process which were to be carried out during the spring and winter maintenance periods and on improvements to be carried out in the production season. These were submitted to the management of the factory in writing in April, June and Oktober 1979 and are, therefore, not included in this report in detail, though the activities proposed and carried out are described in the findings.

Project background

A small sugar factory was established at Jowhar in the year 1927. The production of cane and sugar remained constant until the present plant was put up in 1963. The production of sugar then increased gradually from year to year until the 1971/72 season. The installed capacity of the plant, which was 1,650 tons of cane per day, was exceeded in the years 1969 to 1972. The maximum production of sugar (47,530 tons) was achieved in the year 1970/71. Since then, there has been a gradual decline in production which still continues. The capacity of the plant was increased in 1976 to 2,200 tons of cane per day by adding a mill, boiler, turbo-alternator, pans, evaporator bodies, centrifuge and other supplementary equipment. The present capacity is capable of producing about 45,000 tons of sugar per year. In spite of the expansion, the capacity utilization has been 60% or less and overall recovery has been declining steadily from 79% to 65%.

Annex II gives the data and results of production for each production season from the start of the present plant in the 1963/64 season up to 1979/80.

The Italians who were running the factory left the country when the factory was nationalized in 1970. All the workers, both skilled and semi-skilled, were local people who had been guided and supervised by the Italian foremen and supervisors. When the Italians left suddenly, there was a vacuum which could not be filled.

The factory has its own sugar-cane farm covering an area of about 8,000 hectares of which about 5,000 hectares are actually planted with cane. The sugar content in the cane, as well as the yield of cane per hectare, have declined over the years due to increase in the salinity of the soils for want of proper drainage.

SNAI is the only large complex of agriculture-based industry in the country. The sugar factory has its own workshop, oxygen plant and a distillery and supports a number of ancillary industries offering direct and indirect employment to a number of people in the area.

The problems faced by the industry include a decline in the quality and yield of sugar cane, a scarcity of trained manpower, lack of spare parts and old equipment. Steps are being taken under the development programme to provide 20 million Somali shillings (SoSh) for modernization of the factory and an equal amount for the development of the sugar-cane area. A further sum of SoSh 30 million is available from the Federal Republic of Germany for the above purposes.

The development programme has two sets of objectives, short-term and long-term. The short-term objectives are to implement recommended improvements using the available equipment, personnel and workshop facilities so as to reach an annual production of 45,000 tons of sugar in a period of 2 years. This includes an intensive training programme for the personnel. The long-term objective is to increase the factory's capacity to 50,000-55,000 tons of sugar per year by installing new equipment and replacing some old equipment so that the plant can handle 120 to 130 tons of cane per hour. While this is being achieved, the sugar-cane growing area and the agricultural machinery can also be geared to harvesting and transporting the increased quantity of cane which will be needed at the factory. This may take three to five years, depending upon the availability of material and trained manpower.

This improvement programme has great significance for the economy of the country since sugar is at present imported to meet demand and it is anticipated that the consumption of sugar will increase in the future. The planned increase in production would not only save foreign exchange but would also provide employment for many more people.

SUMMARY OF RECOMMENDATIONS

A comprehensive programme for the rehabilitation of the SNAI sugar factory is detailed in this report.

The present condition of the plant and equipment and ways of bringing it to its installed capacity of about 45,000-50,000 tons of sugar per year with an acceptable level of efficiency are described.

It is envisaged that, when all the recommendations are implemented, the overall extraction should go up to 82% as against a mere 66% during the last three years. The average production during these three years was about 25,000 tons of sugar per year.

With an increase in efficiency alone, say with an overall extraction of 79%, the sugar production would go up to 30,000 tons per year even with the same quantity and quality of cane. At a cost of production of SoSh 310 per quintal of sugar in 1979, the extra income works out to SoSh 15.5 million per year.

The fuel oil and diesel oil used in the boilers comes at present from imported petroleum and alone costs about SoSh 5 million per year. Recommendations are given for improving the plant's fuel economy.

With an increased production of 45,000-50,000 tons of sugar per year, coupled with savings in fuel oil, the total additional income will more than justify the rehabilitation programme and the money invested in the whole programme will be paid back in two years' time.

The improvements which can be undertaken with the existing personnel and material available locally are listed separately from the machinery to be imported.

The work which can be done locally can be started in the coming maintenance period and may spread over 2 or 3 maintenance periods. The suggestion of lengthening the maintenance period at Jowhar after the Juba Sugar factory starts production in order to hasten the improvement programme, should be seriously considered.

It is understood that action has already been taken to import the equipment mentioned in the report, in which case the entire programme can be completed within the coming three years.

It is also necessary in the meantime to prepare the cane fields for mechanical harvesting and to re-schedule the cane-plantation programme.

As mentioned in the recommendations, the old and over-mature cane which is accumulating year after year should be put to economical use in manufacturing brown lump sugar known as gur or jaggery in India. It may be worthwhile to consider having jaggery-making plants in various isolated pockets in the country where sugar cane can be grown on a small scale.

Recommendations are made for producing semi-refined sugar if a need arises in future.

Equal importance is given in the recommendations to training all personnel from top-level to semi-skilled, and also to establishing a training programme for new trainees.

The specific details of all these recommendations are to be found in chapter II.

I. FINDINGS

A. General observations

There are two sugar-cane seasons. The first begins in June and lasts until early October and the second one starts in December and runs through the months of January, February, March and the first part of April. These are the normal dry months in Jowhar, totalling about 240 days in a year. The sugar-production years run from June of one year to April of the next and have been numbered consecutively since the factory started operating in 1963 (see annex II). Each production year is subdivided into season 1, starting in June, and season 2, starting in December. The periods between the production seasons are used for maintenance work in the factory.

The 16/2 production season ended on 13 April 1979, which gave the expert a few days to see the factory under working conditions. The working of the factory was very inefficient with many breakdowns towards the end of this season.

After discussing the immediate problems with the factory's technical staff, a few modifications were suggested and carried out using the existing idle machinery and the available personnel without disrupting the general maintenance of the factory.

Maintenance of the plant and machinery before the 17/1 season was very poor. There was no planned overhauling schedule, particularly with reference to the units where frequent breakdowns had occurred during the previous production season. The workers carried out the maintenance in the same way that they have been doing for years. Units and individual machines are dismantled, opened and cleaned. Broken and worn out parts are replaced. The machines are reassembled and painted. There is no supervision by any competent foreman or engineer during overhauling or before reassembly of any unit. No one is held responsible if any machine or unit breaks down immediately afterwards in the production season. The overhauling work is given on time contract to the workers. If they complete the work in a shorter time every day, they can go home rather than staying for eight hours. Therefore, the tendency is to complete the work in as short a time as possible. This has resulted in the equipment becoming faulty and in frequent breakdowns during the production season. Lack of spare parts for replacement during the overhauling period appears to be another reason for breakdowns. There is no system of preventive maintenance anywhere in the factory and this adds to the stoppages of production through breakdowns. Nearly 40 per cent of the time available for crushing is lost for various reasons. Nearly three fourths of the time lost could be saved and used for production.

There were endless breakdowns from the very start of the 17/1 campaign.

B. Raw material

Another problem is the quality of raw material. The cane crushed during the 17/1 production season was of poor quality. The age of the cane varied from 17 months to 5 years. The bulk of the cane crushed was N.CO. 310. The ideal time to harvest this cane is when it is 11 to 12 months old.

The fibre in the cane was high and pith formation in the centre of the cane was common. The result of this was low juice content in the cane, high reducing sugars and non-sugars in the juice, and difficulty in milling and processing. Although a selective harvesting system is practised in principle, it is not strictly adhered to for each and every block of field. Due to irregular crushing during the previous few years, the left-over cane in the field accumulated and naturally became over-mature. The cumulative effect is now that the cane available is always over-mature, the average age being about 20 months. This vicious circle is to be broken by discarding the over-mature cane in any one year and making available a sufficient quantity of twelve-months old cane in that year, so that the following seasons will have only cane of an optimum maturity. This will increase not only the yield of cane per hectare but also the sugar content in the cane. The over-mature cane can be put to other uses as mentioned in the recommendations.

Cane harvest and transport

Cane is burnt the previous evening for harvesting the following day. The cane is cut, trimmed and piled up all by hand. Loading into rail wagons or tractor trucks or carts is done by cane-loaders. Although mechanical chopper-harvesters were introduced in December 1977, their operation was not very successful due to the lie of the land which was not suitable for harvesters. The land is being levelled and drainage channels laid at longer intervals so that the harvesters can have a reasonable run. It may take some time to level all the land to suit the harvesters. A small quantity of cane is cut every year using the harvesters. The quantity cut by harvesters in the 17/1 season was nil and in the 17/2 season was 38,319 quintals. An adequate number of wagons to transport the chopped cane is not available since specially-built wagons are needed for this purpose.

The amount of trash brought with the chopped cane during the 17/2 season was calculated and it ranged from 6.1% to 15.0% on the cane, the average being 9.13%. This calculation was done when the cane was harvested in very dry conditions. The percentage of trash may increase when harvesting starts after the rains.

The South African Sugar Association Experiment Station conducted experiments in 1977/78 using a chopper-harvester and found that about 11.3% of millable cane was left in the field when compared to hand-cut cane. The sugar content in cane chopped by harvester also deteriorates faster depending on the length of time between harvesting and milling and the climatic conditions of the region. In warm climates, the deterioration is rapid.

The number of the people required for harvesting the cane manually are not always available due to various seasonal and local conditions. Harvesting is done in the daytime and transport of cane is done round the clock. There are about 350 wagons to transport cane on the rails and about 75 cuban carts drawn by tractors. The self-discharging trailers purchased in 1977/78 appear to have various problems which prevent them from operating successfully.

There are two types of wagons with two different wheel centres, which makes it difficult to devise a suitable arrangement for placing the wagons accurately on the tipper. Nearly 10% to 15% of the wagons are always out of action due to falling off the truck line or some other cause. Re-laying the entire truck-line with sand cushioning, sleepers at proper intervals, proper fish-plates welding the track, maintaining an inspection and repair squad and lastly maintaining a strong repair crew at the wagon-repair shop would all alleviate the above problems.

The cane transported by wagon is weighed by a manually-operated weighbridge which is situated more than a kilometre away from the factory. The cuban-cart cane is weighed inside the factory by a similar weighbridge. About 80% to 90% of the cane is transported in rail wagons and the rest by tractor-drawn carts. Since there is no round-the-clock supervision at the weighbridge away from the factory, the cane coming during the night-time is not weighed properly. This results in improper accounting of the raw material. The weighbridge could be shifted to a convenient place inside the factory where effective supervision can be excercised.

Cane feeding and preparation

Derailment of cane wagons before coming on to the tipper is a common occurrence. This could be avoided just by concreting the rail track from the canal bridge up to the tipper after relaying and aligning the rails properly. This recommendation has long been awaiting implementation.

Another recommendation made earlier should be seriously considered, i.e. that of installing winches or spotters for pulling the loaded wagons on to the tipper and for pulling away the empty wagons so that the engines which are now used for this purpose can be withdrawn. If the wheel centres of the wagons are made the same, then location humps can be welded on the rails so that the loaded wagon can slide into position on the tipper, avoiding manual adjustments and loss of time in placing the wagon on the tipper. The tipper itself gave a lot of trouble during the 17/2 season and ultimately it was replaced by a new one.

The No. 2 feeder-carrier broke down often during the 17/2 season. The carrier needs a thorough overhauling and replacement of the drive-shaft and sprockets and the slats. The motor is inadequate in capacity and is overloaded all the time.

While the preparation of cane is inadequate, the poor maintenance of preparatory equipment makes it still worse. There is no regular scheduled inspection or change of knives. The number of knives in the first and second sets is inadequate. Chopper-harvested cane cannot be handled by the existing sets of knives and therefore it is very necessary to instal a shredder as soon as possible so that the harvesters can be utilized to a greater extent.

Loading of cane into the cane carrier should be uniform and without gaps. Operators should be trained to feed the carrier properly. The cane-carrier speed control is a multiple-speed device using a rheostat. However, it was out of order and an on-and-off method was adopted for driving the carrier. During the 17/2 season, it was partially rectified and three-speed controls were restored. but the operators still prefer to use on-and-off control only. With this type of operation, the mill-feeding is not regular which affects the extraction and the capacity of the mill. This is another major reason for the high moisture content in the bagasse. During the 17/1 season, it was often necessary to add diesel oil to the bagasse before feeding it into the boilers to make it burn. This is in addition to burning diesel-fuel oil in one of the boilers. This is an extremely wasteful method.

C. Milling

Changes in the mill settings in the 17/1 and 17/2 seasons were tried, the moisture content of the bagasse came down to 52%-54% and the bagasse burned in the boilers fairly well. The consumption of fuel oil and diesel oil in the boilers came down sharply during the 17/2 season.

With a good cane preparation, a primary extraction of at least 75% should be aimed at in order to achieve a good mill extraction.

A lot of bagasse falls into the juice gutters from the mill rollers. The primary reason for this is that the chevron grooving is cut too deep. Chevron grooving should be cut to a third, or at the most to half, the depth of the present grooves.

Because of excess bagasse falling into the mill juice gutters, a cush-cush strainer was introduced for the first three mills, but it later became a nuisance. The cush-cush strainer broke down very often. Removing the screens from the cush-cush strainer, thus defeating the purpose and sending the juice directly to the pumps, is a common practice. The cush-cush strainer contributes to the imbibation-juice receiving tanks becoming a breeding ground for micro-organisms.

To begin with, the falling of excess bagasse into the juice troughs should be stopped. Secondly, the existing imbibition-juice receiving tanks should be replaced by cylindrical swirl tanks so that the chokeless pumps can work smoothly and continuously. The present practice of a man sitting and switching all the imbibition pumps on and off can be avoided. This may involve deepening the pump pit by half a metre to accomodate the cylindrical tank and pump. Then the cush-cush strainer and the screw conveyor can be discarded.

The rollers get smoothed down after crushing for a month or so and then the mill starts slipping. The practice of welding the roller surface to roughen it was introduced during the 17/2 season and it is working well.

The intermediate carriers, particularly the one in between the 2nd and 3rd mills, fail very often. Replacement takes nearly 3 hours. This can be avoided by proper and regular preventive maintenance.

The imbibition troughs over the mills are not functioning as they should due to excess bagasse falling into the juice gutter. The present system of pumping the imbibition juice in spurts should be avoided by by-passing part of the juice back into the juice gutter. This will aid in flushing out the fallen bagasse, will keep the pump going continuously and ensure a fairly uniform supply of imbibition juice.

It is advisable to think of changing the grooving of the rollers of the last two or three mills to a lesser pitch. This may improve extraction and reduce the moisture in the bagasse. This can be done only over a period.

The bagasse elevator after the last mill breaks down at least twice in every season. The problem is that either the motor burns out or the reduction gear breaks. The horsepower of the motor and of the reduction gear is inadequate to cope with the load. The entire drive unit should be replaced.

It was the practice here not to weigh the imbibition water, but to calculate it by the direct method. This does not always give a correct weight since it depends in turn on the correctness of the fibre determination. The method of determination of fibre in the cane is wrong. A piece of clean cane is taken and shredded and the amount of fibre is determined. The whole cane delivered to the factory is different from the piece of clean cane taken for fibre determination. As a matter of fact, the fibre content in the whole cane was 2 to 3% higher than that determined by the above method. These inaccuracies in determining the percentage of fibre in the cane and of imbibition water do not help either the engineering department or the process department in guiding operations. Because of this, a simple arrangement to determine the weight of imbibition water used was devised. Two of the unused cylindrical tanks were used to measure a predetermined quantity of water and this water was discharged, one tank at a time, into a receiving tank and was then used for imbibition. The weight of water used is easily calculated from the number of tanks discharged in each shift. Since the mixed juice is weighed accurately, the weight of cane plus the weight of imbibition water minus the weight of mixed juice gives the weight of bagasse. From this, the percentage of fibre in the cane is calculated. This calculation is counter-checked by determining the fibre in the whole cane using a warring blender. A composite sample is taken along the whole width of the cane carrier before the prepared cane enters the first mill. This procedure gives the fibre content in the cane fairly accurately.

D. Steam generation

The new Mario Pensotti boiler is not of a good design. It breaks down often. The tubes leak, the furnace wall collapses, the induced-draft fan breaks down and so on. Maintenance of this boiler appears to be difficult and repairs are cumbersome. During the 17/2 season, the economizer sprang leaks.

This is a fully automatic boiler but none of the automatic instruments work and most of the instruments are out of order and need replacement parts. This is the only boiler which can be used with fuel oil as well as bagasse, either together or separately.

A thorough cleaning and overhauling of the boilers was carried out during the last maintenence period before the 17/2 season, but it was not effective. Balancing of the duct fans must be done carefully during maintenance. The worn-out flue-ducting on the BR1 and BR2 boilers must be replaced.

There is plenty of fly ash around. The existing fly-ash removal system is not maintained and not used. This should be thoroughly repaired, particularly by replacing the worn-out ducting, and put into operation.

The boiler feed-water pumps are unable to pump water above a temperature of 85°C. In fact, cold water is added to the hot condensate to bring the temperature down to 85°C and below. Phosphor bronze pumps to pump water of a temperature of 100°C should be installed so that the closed system of condensate collection can be used and the temperature of boiler feed-water can be maintained as high as possible. This will increase the efficiency and output of the boilers and save fuel.

The boiler feed-water line very often springs leaks. The old defective lines should be replaced.

Out of the two turbine-driven and four motor-driven boiler feed-water pumps, half are always out of order. All boiler feed-water pumps should be kept in order and worked alternatively. This is an important station and particular attention should be paid to it. The insulation of all feed-water and boiler hot-water lines should be completed.

A periodical cleaning schedule for the boilers should be established in every shift during the production season. With bagasse of a lower moisture content and with optimum operation of the boiler, the burning of fuel oil could be totally avoided. Only a minimum number of boilers need to be in use, while the others can be cleaned and kept in reserve.

Wastage of steam is very great as the exhaust steam is blown out frequently and there are condensation and radiation losses due to the steam pipes, hot pipes and vessels not being insulated.

Exhaust steam is blown out about 50 per cent of the time, which is a tremendous waste. At the same time, crushing is stopped frequently because the boiler pressure goes down below 20 kilogrammes per square centimetre. Live steam is constantly bled into the exhaust and this is not stopped. Live steam is also supplied to the distillery. The automatic valve which bleeds the live steam into the exhaust should be set right and exhaust steam should be supplied to the distillery instead of live steam.

The boiler feed-water temperature is kept low to facilitate pumping. This is another point at which the efficiency of the boiler is reduced. The overhead boiler feed-water tanks could be raised to give enough head for the pumps so that the temperature of the water can be raised to the maximum possible.

The instruments which measure the carbon dioxide content in the flue gas from the boiler do not function.

It is proposed that a steam accumulator should be included in the long-range programme to avoid wastage of steam.

An ion-exchange water-treatment plant for the boilers appears to be an immediate necessity.

E. Power generation

There is one 3,000 kilowatt turbo-generator which is fairly new and one old 2,500 kilowatt turbo-generator. Apart from these, there are two old ones of 1,000 and 750 kilowatt capacity respectively, of which the latter turbine requires major repairs.

The turbo-alternators are housed next to the boilers and the place is very dirty with boiler soot and dust. The air- and water-cooling systems are installed in an inconvenient and inaccessable place where there is no proper lighting.

A proper ventilation system should be installed where the turbo-alternators and the control-panel boards are housed. There are a number of exhaust fans installed in the building but none of them are in working order. They should be put into commission immediately. Most of the time, the turbo-alternator operator prefers to sit outside the place of work since it is too warm to sit inside. One of the ways to keep the dust out and keep the room reasonably cool is to pump in constantly-filtered fresh air and to keep the turbo-alternator room closed so that the air pressure inside the room is very slightly higher than outside and the dust and soot cannot enter.

It would be advisable to have one more turbo-alternator of 3,000 kilowatt capacity as a standby for the present ones, some of which are unreliable.

The number of electrical motors burnt out during every production season ranges from 30 to 40. Investigations should be carried out into the procedure followed in overhauling and rewinding the motors and any necessary modifications introduced. Particular attention should be paid to the quantum of loads connected to the motors and the protection devices installed for the motors. It is also necessary to repair and re-lay the electric cables in the factory. Necessary safety devices should be installed.

F. Juice clarification

The quality of liming is inconsistent. Since the density and also the volume of milk of lime added per tip of the weighed juice are constant, the pH of the juice is subject to fluctuations. By adjusting the volume of the milk of lime frequently, the pH of the clarified juice can be kept reasonably constant.

The temporary arrangement for fractional-liming and double-heating, which is a simple automatic device without any moving parts introduced in the 17/1 season, is working satisfactorily. The clarified juice is reasonably clear and free from suspended particles. Arrangements to add separan to the treated juice and to the filter mud were also made in the 17/1 season and this has improved the clarification and mud-compaction.

The stirrer in the second limed-juice tank was out of order most of the time during both production seasons. Instead of the present arrangement, it is proposed to install a suspended shaft with two outboard-motor propellers attached to the bottom of the shaft. This arrangement is simple, effective and trouble-free. If this is not possible, foolproof arrangements must be made to work the existing equipment without breakdowns.

The clarifier has seven settling compartments and seven clear-juice draw-off pipes. It was the practice in this factory to draw the juice only from the top 3 or 4 pipes and keep the others closed. This is not the correct way of working a clarifier. It was also the practice to draw the juice from the clear-juice tail-pipes and pump it into the clear juice draw-off box, even when the mill was crushing continuously. All these practices have been stopped, the clear juice is now drawn equally from all the seven draw-off pipes and the clarifier is working normally.

It appears that the operators as well as the shift supervisors do not understand the importance and implications of maintaining correct pH and correct temperatures in the juices. Not much care is taken in the preparation and addition of milk of lime. Their idea seems to be that, if the cane is crushed, the sugar will come out automatically into the bags so long as the machinery in the process department is kept running. This lack of understanding of the production process is a big hindrance to the efficient working of the units and to any attempt to reduce the losses in the process. However, by the production manager holding frequent meetings with the foremen and supervisory staff and explaining to them the basic reasons for the technology, they were convinced to some extent.

It is proposed to install a pipeline direct from the bottom of the clarifier to the mud-receiving tank, with a valve so that the mud from the clarifier can be discharged into the mud-receiving tank and then pumped to the bagacillo-mixing tank. The two mono-pumps now used to pump mud from the clarifier to the bagacillo mixer can be shifted to the mud-receiving tank and the two centrifugal pumps of the mud-receiving tank can be discarded. A closed steam-heating coil can be provided in the mud-receiving tank to maintain the temperature of the mud.

G. Juice filtration

The main modifications carried out were in the separation of bagacillo and the bagacillo-mixing tank. The screening area for bagacillo was doubled by installing an extra screen. A screen of No. 8 mesh is ideal, but in the absence of 8-mesh screen a slightly larger mesh was put in. This has greatly improved the bagacillo supply, although the bagacillo was not as fine as required. This renders the filter cake more porous, with the result that the polarization in the cake cannot be brought down to the minimum but it does remain at a reasonably low level.

The original recommendation was to have a series of 8-mesh screens under the bagasse elevator with the possibility of shutting off some of the screens and keeping open only the required number according to the needs of the bagacillo. The blower should also be shifted to a place under the bagasse elevator and the bagacillo pipeline should be straightened as far as possible.

The second modification was in the bagacillo-mud mixer. The existing outlet was removed and an overflow weir all along the width of the mixer was fixed at the farther end. A perforated pipe to add milk of lime was fixed across the mixer at about a third of the distance from where the mud and bagacillo enter.

Another perforated pipe was fixed just ahead of the overflow weir for adding separan solution. This helped to raise the pH of the mud to about 8.5 and then separan solution was added. This gave a compact mud and the filters worked better. The mud-mixer was also insulated which helped to keep the temperature of the mud as high as possible.

All the wash pipes on the filters were removed and replaced by new pipes and new spray nozzles to make washing of the cake more effective.

Steam pipes with perforated holes for heating the caustic-soda solution were installed in the mud-trough under the filter drum and also along the filter drum under the scraper to clean and steam the screens on the filter drum. These modifications enabled the filter screens to be cleaned with steam during every shift when the filter is in operation, and with caustic-soda solution once a fortnight.

The entire filter station worked reasonably well throughout the two production seasons. Because of the higher retention of mud solids in the filter cake, the filtrate returned to the process contained less mud solids, thereby improving the performance of the clarifier.

The quantity of filter cake produced has been determined by guesswork all these years. A quantity of 2% of the cane was taken as the amount of filter cake produced. This is not at all correct since the quantity changes depending on the quality of the cane and the efficiency of the clarification station. Counters were installed in each of the filters which automatically count the number of revolutions made by the filters. In each shift, the filter cake on a segment of the surface of the filter was scraped off and weighed and the weight of filter cake per revolution calculated. The total quantity of the filter cake is calculated from the number of total revolutions the filters make. This gives a more or less accurate figure for the quantity of filter cake produced. It was observed that the filter cake produced varied from 3.5% to 4% of the cane.

The filtrate pumps and the vacuum pump broke down often during the 17/2 season. Particular attention should be paid to maintaining this equipment.

H. Evaporation

No modification was made to this station except for installing a cylindrical tank to measure the condensate from each body calendria in order to evaluate the performance of the body. This was never tried out since there was no steady and uniform crushing for an extended period.

There was no problem in this station because of the low crushing rate. The vacuum was quite low during the 17/1 season. The capacity of the vacuum pump is insufficient to cope with both the evaporator and the pan stations. During the 17/2 season the standby vacuum pump was also used and the vacuum in the system was satisfactory. The steam vents from all the juice heaters are connected to the condenser of the evaporator. These vents were diverted to a manifold pipe leading outside the building and the vacuum increased by 5 cm mercury.

The vacuum in the system can be improved by converting the existing barometric condensers into rain- and shower-type condensers. This was recommended in 1977/78. The modification is simple and could be done in the maintenance period.

The temperature of the exhaust steam in the first body calendria was too high, ranging from 180°C to 200°C. This increases the rate of inversion of sugar. The temperature should be kept around 135°C. The de-superheating system did not work at all. In the 17/2 season, certain adjustments were made and the water inlet into the de-superheater was controlled manually. The exhaust-steam temperature was maintained around 150°C.

The steam inlet valve is always kept open and is never throttled even when the crushing stops. The valve is large and requires a number of men to operate it and this discourages them from periodically adjusting the valve as required. It is preferable to operate the valve with a motor and reduction gear so that the valve can be adjusted at will.

To soften the scales in the evaporator tubes, caustic-soda solution is boiled. The scales were often hard. It is suggested that boiling acid should be used after boiling caustic soda, followed by mechanical scrapers.

The installed capacity of this station is ample. It is suggested that the position of the bodies should be changed as suggested in the recommendations on rehabilitation. It is necessary to install an automatic juice-level controller in the first body.

The condensate-extraction system is not perfect, particularly in the last two bodies. There is frequent water-hammering in the last body. The condensate pipelines from the last body are too long and have many bends. The condensate-extraction pumps could be re-installed under the last body.

Before starting the 17/1 season, the uncondensable-gas pipes from the last body calendria were increased.

There were many pipelines in the clarifier and filter stations which were not used and were lying idle in various places. It would be worthwhile to remove all unnecessary pipes, keeping only what is in use.

I. Pan boiling and crystallization

The capacity of the pan station is quite generous for the installed capacity. The main problem appears to be lack of sufficient vacuum for all the pans and the tendency to boil the massecuite in a pan for a prolonged time, nearly twice the time normally required. This leads to inversion and increases the viscosity of the massecuites.

There are leaks in the vapour lines from the pans and also in the pan bodies. The vapour lines are worn out and thin and two pipes collapsed under vacuum at the beginning of the 17/2 season. Frequent checking for leaks and replacement of worn-out pipes are necessary. The pans, along with the vapour lines, should be tested for leaks by filling them up with water before starting production.

Since the capacity of the vacuum pump is insufficient, it is advisable to use the minimum number of pans possible. This was tried for some time during the 17/2 season and the vacuum in the system was better. Later, two vacuum pumps were put to work because the leaks increased.

The average boiling time for a C-massecuite, after taking the grain footing, is about 20 hours, which is far too long. With the available equipment and a fairly good vacuum, it should take about 8 hours. Vapours from the first evaporator body can be used for boiling the C-pans instead of using vapours from the second body. This was tried during the 17/2 season and an improvement in boiling was noticed.

Graining for the C-pan is done in syrup, using fondant slurry as seed. This gives a higher purity C-footing than is needed. It is advisable to use a mixture of A-molasses and syrup, say half and half, so that the resultant purity comes to about 75.

On analysing the cyclone purity of C-molasses when the pan is dropped, it was observed that the extraction of molasses in the pan was poor and that the purity drop of molasses was hardly 10 units. This shows that the pan boiling is inadequate. The tubes in the pans were cleaned during the 17/2 season but there was no significant improvement. It was suspected that the circulation of the massecuite in the pan might be sluggish. It was agreed to install an open steam coil under the bottom tube plate and to introduce exhaust steam into the pan when the pan is half full to improve the massecuite circulation. This is expected to be completed in the coming maintenance period.

Pan aid was tried during the 17/2 season to reduce the viscosity of C-massecuite and the results were encouraging.

There is no crystallizer to store C-grain. It is preferable to install a vacuum crystallizer on the pan floor to store the grain. This crystallizer could be made in the workshop here.

There are three pans to boil B-massecuite. Of these, B1 pan is the smallest and can be kept idle since the other two pans are more than sufficient to boil B-massecuite. B1 pan could be used to store C-grain for the time being.

There are three pans for the A-strike. With a reasonable boiling time, two pans are adequate to handle all the A-massecuite. Shutting down one A-pan and one B-pan will greatly improve the vacuum in the system.

The present system of working on the pan floor is to be reorganized when enough trained people become available. Each massecuite, A, B, and C, is boiled by a team of pan boilers independently. There does not seem to be any co-ordination of the management of the pan floor as a whole. It is necessary to select one good senior pan boiler as a head boiler and he should supervise the overall working of the pan station.

All the pan-washings go into the crystallizers diluting the massecuites. Thus all the good work done in the pans is lost. This was established during the 17/2 season by analyzing the cyclone purities of molasses of all the massecuites while dropping and after remaining in the crystallizers for some time. The cyclone purity of molasses from massecuite remaining in the crystallizer was always higher than that of dropping massecuites. Arrangements should be made to collect the pan-washings separately and send it to the mixed-juice receiving tank. This was tried during the 17/2 season but it could not be continued since there was no separate pipeline to drain off the pan-washings. This has to be looked into in the coming maintenance period. When the pan-washings were separated for the A-pans, the purity of A-molasses came down.

C-massecuite becomes viscous whenever stale or over-mature cane is used. Pan aid was tried and the massecuite became manageable.

A microscope was used during the last two seasons by the C-pan boilers and they are getting used to it. Cuitometers should be installed, at least for the C-pans, so that there is a proper control on pan boiling.

The cyclone purity of molasses of all massecuites should be determined once in a while to judge the work done by the pans and crystallizers. Determination of the apparent crystal content of each massecuite will give an idea of the quality of massecuite and the efficiency of the pan boilers. The instrument to measure the apparent crystal content can be made in the workshop.

A- and B-molasses should be diluted to 75°Bx and heated to 75°C before feeding into the pans. This is necessary since the molasses contains plenty of sugar crystals.

There are a suffucient number of crystallizers for all the massecuites. The C-crystallizers are equipped with blanchard-type, water-cooled elements. However, they are always leaking and are not used for water-cooling. Although it is time-consuming and tedious to weld all the leaks in the elements, the work has to be done as soon as possible so that the excess loss of sugar in the molasses can be minimized. All the eight crystallizers should be interconnected to form one continuous crystallizer. It may be necessary to install two receiving crystallizers above the C-crystallizers. This proposed arrangement would improve the massecuite treatment to a great extent and increase the holding capacity. The last crystallizer can be used to reheat the massecuite to about 50°C. This will facilitate the pumping of the massecuite. Further reheating can be done in the pugmill.

J. The centrifuges

The installed capacity of the centrifugal station is quite large, but half of the machines are always out of order for want of spare parts or motors or because of electrical faults. This state of affairs continues year after year and it is high time to bring all the machines into working order. Although it is not necessary to use all the machines, they should be kept ready for any eventuality.

The centrifuge baskets are not dynamically balanced from time to time. This is a very important aspect of maintenance which should be carried out regularly. Accidents happen when the baskets go out of balance.

The centrifuge screens were replaced frequently during previous seasons because they got damaged and torn off. But during the 17/1 and 17/2 seasons, there were practically no such replacements. This can be attributed to good clarification of the juice and the mud not being carried over through the syrup to the massecuites and finally to the centrifuges, thus blocking the screen holes.

The C-pugmill has got a stationary heating coil for reheating C-massecuite. This coil was leaking badly and was never used. The coil was removed during the maintenance period and the leaks were repaired and the coil put into use during the 17/2 season. It was useful to some extent. The pugmill itself could be jacketted and hot water circulated through the jacket to reheat the massecuite. This can be tried during the coming maintenance period.

The capacity of the C-centrifuge can be increased by 50% by properly reheating the C-massecuite.

The No. 1 continuous-centrifuge machine has a narrow pipe from the pugmill to convey the massecuite, which means that the required quantity of massecuite could not be fed into the centrifuge, forcing the centrifuge to work at half its capacity. This was rectified by replacing the pipe with a larger pipe and valve and during the 17/2 season the centrifuge worked at its full capacity.

The screw conveyor under the C-centrifuge breaks down very often. It would be ideal to have the C-magma mixture directly under the centrifuge. Since the centrifuge's foundation does not permit this, it is advisable to have a perforated pipe just above the screw conveyor and add A-molasses directly onto the C-sugar in the screw conveyor itself. The sugar forms a magma and flows into the magma mixture. The screw conveyor should be made to incline slightly towards the magma mixture to facilitate the free flow of the magma along the screw.

Washing of sugar in the A-centrifuge and also in the B-centrifuge is not properly done. It was observed that the water-spray nozzles in the baskets do not function properly and the spray does not cover the entire height of the basket. The spray nozzles must be corrected and adjusted properly.

A-sugar should be washed for about 15 to 20 seconds. It is preferable to wash it twice instead of once. The timing of the washing should be adjusted so that the first washing starts immediately after the molasses drains out of the sugar in the centrifuge basket (duration of washing about 10 seconds), followed by an interval of 10 seconds and then the final washing, which should be completed before the maximum speed of the centrifuge (1,440 rev/min) is cut off.

Falling of massecuite and water drippings into the grass hopper are to be avoided to keep the sugar clean.

The equipment for separating the A-washings from A-molasses is defective and this should be thoroughly overhauled and repaired. Effective functioning of this is very crucial for maintaining low A-molasses purity.

A-, B- and C-massecuite and A- and B-molasses purity should be controlled and maintained within the specified limits in order to achieve maximum recovery of sugar at each stage and minimize the losses in the final molasses. To obtain the optimum conditions for good exhaustion of molasses, the size of sugar crystals should be maintained as far as possible as follows:

C-sugar about 0.35 mm
B-sugar about 0.6 mm
A-sugar about 1.2 mm.

II. RECOMMENDATIONS

The 1977 report "Rehabilitation and improvement programme for the SNAI sugar plant" gives very detailed recommendations for the improvement of the factory. Since they have already been given in detail, only the main recommendations are outlined here.

Capital expenditure on imported equipment is kept to a minimum and only the most essential equipment is recommended for inclusion in the long-range as well as the short-range programme.

The work which can be undertaken by SNAI with their existing manpower and equipment is listed first. It may take two or three maintenance periods to complete the jobs, depending on the work-load of normal maintenance. Since the Juba Sugar Factory will start producing sugar from July 1980, the scarcity of sugar may not be felt so much. In that case, it would be advisable to extend the length of each maintenance period by, say, 3 to 4 weeks and to utilize the entire manpower to complete all the new jobs in one year. A schedule of priority can be drawn up for this. This is suggested because it is not possible to get extra manpower to do these jobs simultaneously with the normal maintenance carried out by the staff.

The second section gives recommendations for the longer-term reconstruction and modernization of the factory, and the third section deals with training of personnel.

A. Immediate improvements

Cane transport and handling

1. The railway line is to be re-laid on a firm base to avoid wagon derailments and help speed the movement of wagons.

2. The weighbridges for the cane wagons should be shifted inside the factory compound to avoid incorrect recordings of cane weight.

3. The railway line inside the factory, i.e. from the tipper to the canal bridge, should be realigned and concreted to avoid wagon derailments before the tipper.

4. The wagons must be thoroughly repaired. The wheels, load-springs and the side-angle supports must all be corrected.

5. A maintenance squad for the inspection and maintenance of the railway line during the production season should be made available.

6. Strict control should be excercised at the wagon repair shop so that every wagon is thoroughly repaired. If possible, the wheel centres of the wagons should be made uniform to facilitate positioning of the wagons on the tipper by providing stops.

7. If possible, the tipper should be altered to be able to tip 180° so that chopped cane can be handled.

8. The second feeder-carrier should be completely stripped and overhauled.

9. The concrete foundation for the No. 1 cane-cutter should be strengthened since it broke twice. It is suggested that the number of knives in this cutter should be increased from 12 to 24 to improve the preparation.

10. To utilize the excess cane which has been standing in the field for more than two years, and to break the vicious cycle of having to crush partly old and over-mature cane and partly fresh 12-month old cane, it is proposed to put up small jaggery- or gur-making plants for the unwanted cane. Jaggery is a brown lump sugar made straight from the cane juice without any purification. Jaggery is unknown in this country but it forms more than 50% of the sweetening agents used on the Indian subcontinent. It is manufactured and used in many countries in the far east, some countrics in Africa and central and south America.

The process of manufacture is simple and primitive. The sugar cane is crushed in a three-roller crusher driven by electric or diesel power. The juice extraction is about 50%. The juice as such is concentrated in shallow, open, iron pans over an ordinary furnace in which sun-dried cane stocks from the crusher are burnt. Milk of lime is added to neutralize the juice. When the juice attains a concentration of about 82° Brix, the thick liquid is poured into wooden moulds of any desired size and shape. The thick liquid sets as a solid lump in a few hours time and is removed from the wooden mould by tapping it.

The sweetness of jaggery is about 65% of the sweetness of white sugar. Jaggery is preferred by many as it contains all the minerals in the cane juice.

Mills

11. The cane-carrier speed controller should be made to work at all the speeds provided in the rheostat.

12. Arrangements should be made to sample the first-expressed juice continuously.

13. The existing rectangular mill-juice-receiving tanks could be replaced by cylindrical swirl-tanks, completely removing the cush-cush strainer.

14. Arrangements should be made to return part of the excess imbibition juice back to the mill in order to flush out the fallen bagasse, maintain a uniform flow of imbibition juice, and keep the imbibition-juice pumps running continuously.

15. Better arrangements for steaming the mills, juice troughs and juice tanks and the DSM screen at the mills should be made by providing perforated steam pipes all over. This is important for good mill sanitation.

16. If possible, the drive for the bagasse elevator should be immediately replaced by a motor with a higher horsepower and reduction gear, or at least one spare motor should be kept ready nearby.

17. The bagasse conveyor belt must be renewed completely.

Juice clarification

18. There is one brand new, completely automatic scale lying idle. It is proposed to use this new scale for weighing mixed juice and to use the existing juice-weighing scale for weighing imbibition water.

19. The new pH controller and recorder which is there should be put into working condition by obtaining the necessary electrodes and connecting the liming system. If the pH control is successful, then addition of lime saccharate to the hot juice in the flash tank above the clarifier can be done, as described in "The rehabilitation and improvement programme".

20. All the unnecessary pipelines in the clarifier and filter station are to be removed.

21. The mud-feed line under the filter should be modified to give even distribution of mud into the trough.

22. Arrangements for differential vacuum in the pick-up and drying side of the filter drum should be made by installing a dead-weight globe valve in between the two filtrate receivers. An automatic fisher valve would be the ideal one.

23. The two filtrate pumps should be overhauled thoroughly and a third should be installed as a standby.

24. The mud-outlet line from the bottom of the clarifier should be connected directly to the mud-receiving tank. The two mono-pumps should be shifted to the mud-receiving tank and the two present centrifugal pumps should be discarded.

A closed steam coil, preferably of copper with a steam trap, could be installed inside the mud-receiving tank to maintain the temperature of the mud. An alarm system should be installed to prevent the mud tank overflowing.

25. The old reciprocating vacuum pump under the filter should be put into working order and the present water-ring pump should be placed under the filters. This will avoid lengthy pipelines.

26. The bagacillo-collection system should be modified as described in "The rehabilitation and improvement programme".

27. The caustic-soda-solution pipeline must be extended to these filters.

28. In the evaporator bodies, the steam side of the calendria is to be cleaned of oil, rust etc., since some bodies are sluggish in boiling.

29. The condensate-extraction pumps are to be thoroughly overhauled and, if possible, to be shifted under the last evaporator body.

30. Rearrangement of the evaporator bodies should be undertaken as described in "The rehabilitation and improvement programme".

31. The two barometric condensers are to be converted into rain- and shower-type condensers to improve the efficiency of the condensers.

32. The automatic de-superheating of the exhaust-steam system should be rectified.

<u>Pan boiling and crystallization</u>

33. Proper arrangements for diluting A- and B-molasses on the pan floor should be made. For the time being, the existing arrangements, though inadequate, can be made use of.

34. All the vapour lines are to be carefully tested and weak pipes must be repaired or replaced. Testing with water is the best way if this can be arranged.

35. One vacuum crystallizer can be built in the workshop here for storing C-grain. This should be installed on the pan floor and will help to make better use of the C-pans.

36. A perforated steam coil, with the perforations pointing down, should be installed under the bottom tube-plate of the C-pans to improve circulation in the pans. Exhaust steam should be connected to this steam coil.

37. Two cuitometers should be assembled here and installed in the C-pans immediately to help in graining and controlling the pan.

38. A separate pipeline is to be installed to drain the pan-washings into the melting tank.

39. Two receiver crystallizers should be installed over the existing C-crystallizers. After this, all the present 8 C-crystallizers can be interconnected so that the massecuite flows into one crystallizer from the receiver crystallizer, travels through all the crystallizers and goes out of the last crystallizer, thus making the system a continuous one. The advantages are dealt with in "The rehabilitation and improvement programme".

40. All the cooling elements in the C-crystallizers should be made leak-proof. A closed thermostat-controlled, cooling-water-circulation system is to be built in the workshop and installed. This is for cooling the massecuite. The last crystallizer can be used for re-heating the massecuite.

Centrifuges

41. More than half the number of centrifuges installed are out of order for want of motors and other spare parts. Efforts should be made to repair or replace the motors and to keep all the centrifuges in working order. The missing parts in the control panels must be replaced.

42. The washing system inside the A- and B-centrifuges must be corrected to give uniform washing. This will help to produce better sugar with less wash-water.

43. The A-sugar-washings in the centrifuges should be separated from A-molasses. The existing system is faulty and should be modified and made foolproof.

44. The hot-water unit supplying hot water for centrifuge-washing and pugmill-heating should be made to maintain a set temperature automatically.

45. The C-pugmill should be jacketted for reheating the C-massecuite in addition to repairing the heating coil inside the pugmill.

46. Arrangements should be made to drip A-molasses along the length of the C-sugar conveyor to avoid the frequent breakdowns in the screw conveyor.

47. The automatic molasses-weighing scale should be commissioned to weigh the final molasses continuously.

General

48. The existing fly-ash removal system should be thoroughly repaired and put into operation to avoid the fly ash falling all over the place.

49. The bagasse baling press, which is lying idle, can be overhauled and put into operation. This can be used for baling a specified quantity of bagasse for use at the beginning of the next season. Since the season starts immediately after the rains, the unbaled, loose bagasse is too wet to burn properly in the boilers. Baled bagasse will solve the problem.

50. Over 50 electrical motors were burnt out during this production season which is very abnormal. Efforts should be made to overhaul all the motors properly, varnish and dry them, and test them before connecting them up.

51. All loose, hanging wires, cables and unnecessary wires in the factory should be removed.

52. The injection water-spray tank should be concreted to avoid loss of water by seepage.

53. Lagging of all the steam, hot-water and hot-juice lines and vessels should be completed.

54. The flue-ducting of the boilers should be changed wherever necessary.

55. The boiler feed-water tanks should be raised to the maximum height possible in order to give enough head to the feed-water pumps and to enable them to pump feed-water at higher temperatures.

After discussion with the technical personnel of the factory, a list of priority items which can be undertaken and completed during the coming maintenance period was made.

Since all the work listed above can be undertaken with the existing personnel and available material, the total expenditure is not estimated.

B. Complete modernization

The following is the additional and replacement equipment recommended for the complete modernization of the plant. The machinery has to be imported except for a few items, such as molasses storage tanks, which can be made here. Outside technical advice and assistance may be necessary to erect and commission some of the equipment. It is usual for the machinery suppliers to erect and commission their own equipment for an additional fee. It is envisaged that this job can be completed in 2 or 3 years time if action is taken to procure the equipment as early as possible. It is estimated that approximately SoSh. 15 million will be required. This list includes basic instrumentation of the factory.

Machinery

56. One heavy-duty shredder with steam drive, a Donnelly-type chute and automatic cane-carrier control is necessary to handle chopped cane and improve the preparation of cane to achieve 90% and above opened cells. This will help the mills to do their job thoroughly, increasing the extraction rate and handling the cane at its rated capacity. It may be necessary to remove the No. 1 cane-leveller and to shift the No. 2 and No. 3 cane-cutters down below the cane-carrier and to remove the No. 1 mill to provide enough room for the shredder, shredder-carrier and Donnelly chute. The drives of the cane-cutters, shredder, cane-carrier and No. 1 mill should be interlocked for a smooth working of the units.

57. One balanced-draft water-tube boiler, of 40 tons of steam per hour generating capacity, should be installed in place of the Ruths No. 1 and No. 2 boilers. If necessary, the height of the building could be increased. This will enable one boiler to be cleaned and kept as a spare, since breakdowns in all the existing three boilers are frequent. Two boiler feed-water pumps with drive should form part of this equipment, in addition to all the boiler accessories. Two steam-surplus valves, one for the exhaust line and one for the first-body vapour line should also be included in the above.

58. It is proposed to re-erect one of the good, discarded Ruths boilers near the distillery to provide steam for the distillery during the maintenance period since the molasses produced in the sugar factory cannot all be processed if the distillery works along with sugar factory for only 7 to 8 months in the year.

59. One water-treatment plant to treat about 20 cubic metres of river water per hour should be purchased for use in the boilers and distillery. This is a must since sometimes river water is used with only initial clarification in a clarifier, and this is detrimental to the life of the boilers.

60. One Ruths steam-accumulator of 10 tons steam capacity will help to store the excess steam and release it when the steam pressure comes down in the line, particularly when there is a fluctuating demand for steam in the factory. Frequent blowing out of exhaust steam will cease and this will save precious fuel.

61. One vacuum pump, of 200 cubic metres of air per minute capacity, is necessary to work as a standby for the existing pumps.

62. One water-ring vacuum pump is necessary for the vacuum filters since there is no standby available.

63. Two small air compressors are necessary solely for the boiler instruments and other instruments in the factory without depending on the central air compressor.

64. One 3,000 kilowatt turbo-alternator with control panel as standby to the present one should be purchased.

65. One molasses-storage tank, with 14 metres diameter and 10.5 metres height, similar to the existing one, should be bought, since the present one is insufficient and molasses is sometimes let out into the river.

66. It is necessary to streamline the electrical system in the factory by replacing all the old and inadequate cables. The distribution and sub-distribution boards, bus-bar system and switches should be replaced wherever necessary.

67. Incorporating electrical-resistance heaters for reheating the C-massecuite would be ideal. The existing space in between the pugmill and the continuous centrifuges may not be sufficient to accomodate a conventional type of a resistance heater. New rectangular-type resistance heaters with half the height of the conventional ones are on the market. These may be suitable. Three such resistance heaters are necessary for three centrifuges.

68. The quality of sugar produced now is off-white in colour and has an average polarization of 98.0%. The sugar committee of the joint FAO/WHO Codex Alimentarius Commission agreed on a minimum polarization for mill white sugar of 99.5%. It is advisable to keep the polarization of the sugar around 99.6%.

69. Since the sugar factory at Juba will go on stream in July 1980 and will produce refined sugar, the competitiveness of SNAI sugar will not be so good. It is therefore recommended that the Talodura process should be adopted in conjunction with the Talo juice-sulphitation process which would give a sugar with a specification lying between conventional plantation white and refined sugar. Recently, Mexico has adopted this process with great success (refinado directo). This process claims considerable cost and yield benefits over alternative technologies. Sulphitation equipment was installed in this factory but was not used. The new process could be adopted with minimum additions.

Instruments

70. If the existing pH controller cannot be put into working order, then one pH controller-recorder must be obtained to maintain the pH of treated juice.

71. Two temperature controllers for juices are needed.

72. Rotameters for juice, lime-sacharate solution or milk of lime and separan solution are necessary.

73. 2 cuitometers for C-pans and 6 cuitometers for other pans should be purchased.

74. Steam-flow meters from the boilers to the mill and shredder turbines, the turbo-alternators, and for general service are to be provided.

75. One automatic juice-level controller for the first evaporator body should be provided.

76. All the laboratory equipment recommended in "The rehabilitation and improvement programme" should be procured.

C. Training of personnel

It should be realized that training of personnel at all levels is as important as the modernization and improvement of the factory itself. This aspect has been completely neglected during the last few years. In order to operate and maintain the factory efficiently, it is necessary to train as many qualified people as possible and the following is recommended.

77. Qualified top-level staff should be sent to attend sugar-engineering and sugar-technology courses in Mauritius, India etc.

78. For middle-management staff such as supervisory staff, short courses ranging from 3 to 6 months should be arranged in a country where the sugar industry is in a fairly advanced stage.

79. For foremen and certain categories of skilled technicians, conducted educational tours should be arranged in neighbouring sugar-producing countries.

80. On-the-job training combined with teaching should be arranged for all the skilled and semi-skilled personnel.

81. It is recommended that a number of apprentices or trainees should be recruited from the technical schools and trained over a period in various specialized fields, electrical, mechanical, boiler, turbines, processing etc.

82. It is suggested that a few foreign experts might be employed for a fixed term to work and train the people here, which might work out cheaper in the long run.

Annex I

JOB DESCRIPTION

SI/SOM/79/804/

Post title:	Cane Sugar Industry Technologist.
Duration:	Nine months.
Date required:	As soon as possible.
Duty station:	Jowhar, with possibility of travel within the country.
Purpose of project:	To assist the Government on the operations of the SNAI sugar plant at Jowhar and the implementation of the rehabilitation and improvement programme for the plant.

Duties:

In close co-operation with the management of the sugar factory, the expert will be expected to:

Propose measures to bring production and performance of the factory to acceptable levels.

Establish plant-maintenance procedures and supervise the maintenance personnel as to the correct practices.

Assist in the installation of measuring and control instruments purchased for the factory and carry out the calculations of the heat balance of the plant.

Devise daily and monthly reporting forms for the plant operations, storage of raw materials and finished products.

Assist in training of plant personnel.

Assist in introducing testing methods required for the factory and propose a list of laboratory equipment needed to complement the locally-available testing facilities.

Assist in implementing a comprehensive rehabilitation and improvement programme for the factory.

The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Government on further actions which might be taken.

Qualifications:

Mechanical or chemical engineer or cane-sugar technologist with extensive experience in the management and operation of cane-sugar plants.

Annex II

PRODUCTION SEASONS 1963-1980 AT THE SNAI

Production year	Period	Starting and finishing dates	Days in season No.	Cane crushed Quintals	Sugar produced Quintals	Cane crushed per day Quintals
1 1963-64	1 Period	22/9/63-25/10/63	32	183 215	18 105	5 725
	2 Period	10/12/63-12/4/64	119	722 736	69 957	6 073
	Combined		151	905 951	88 062	6 000
2 1964-65	1 Period	29/6/64-27/10/64	113	695 187	76 428	6 152
	2 Period	20/12/64-28/3/65	93	801 888	85 099	8 622
	Combined		206	1 497 075	161 527	7 267
3 1965-66	1 Period	20/7/65-17/10/65	84	996 041	103 659	11 858
	2 Period	27/12/65-13/4/66	107	1 390 790	142 119	12 998
	Combined		191	2 386 831	245 778	12 496
4 1966-67	1 Period	25/6/66-19/10/66	115	1 651 605	153 674	14 361
	2 Period	16/12/66-27/3/67	101	1 617 215	169 921	16 012
	Combined		216	3 268 820	323 595	15 133
5 1967-68	1 Period	13/6/67-29/9/67	97	1 254 621	127 195	12 934
	2 Period	16/12/67-1/4/68	106	1 513 277	153 951	14 276
	Combined		203	2 767 898	281 140	13 635
6 1968-69	1 Period	17/6/68-15/10/68	113	1 863 178	187 481	16 488
	2 Period	23/12/68-3/5/69	124	2 075 732	211 690	16 739
	Combined		237	3 938 910	399 171	16 619
7 1969-70	1 Period	15/6/69-19/10/69	123	2 224 335	231 630	18 084
	2 Period	13/12/69-6/4/70	113	2 155 305	210 467	19 073
	Combined		236	4 379 640	442 097	18 558
8 1970-71	1 Period	13/6/70-18/10/70	126	2 452 642	255 493	19 465
	2 Period	15/12/70-12/4/71	114	2 181 156	219 802	19 133
	Combined		204	4 633 798	475 295	19 307
9 1971-72	1 Period	16/6/71-11/10/71	114	2 113 241	220 722	18 537
	2 Period	8/12/71-16/4/72	115	2 162 179	201 940	18 801
	Combined		229	4 275 420	422 662	18 669
10 1972-73	1 Period	19/6/72-17/10/72	101	1 877 591	183 058	18 590
	2 Period	8/12/72-25/4/73	120	2 199 028	190 523	18 325
	Combined		221	4 076 619	373 579	18 446
11 1973-74	1 Period	9/6/73-15/10/73	121	2 024 989	156 615	16 735
	2 Period	9/12/73-18/4/74	105	1 904 700	157 231	18 140
	Combined		226	3 929 689	313 846	17 388
12 1974-75	1 Period	24/5/74-10/10/74	110	1 889 639	155 411	17 178
	2 Period	12/12/74-8/4/75	114	1 925 984	174 419	16 894
	Combined		224	3 815 623	329 830	17 034
13 1975-76	1 Period	5/6/75-4/9/75	91	1 431 281	114 888	15 721
	2 Period	5/12/75-10/3/76	97	1 613 941	156 696	16 638
	Combined		188	3 045 222	271 750	16 197

SUGAR FACTORY, JOWHAR

Sugar produced per day Quintals	Polarization in cane %	Overall extraction %	Recovery % of cane	Loss in molasses Pol. %	Loss in bagasse Pol. %	Loss in filter cake Pol. %	Loss undetermined Pol. %
565	12.76	77.75	9.60	12.90	10.93	0.26	0.21
588	12.48	77.68	9.70	10.80	11.00	0.17	0.33
583	12.52	77.63	9.70	11.55	10.99	0.19	0.50
676	13.66	80.66	11.00	9.33	9.84	0.15	0.08
915	13.46	78.41	10.60	9.91	10.80	0.54	0.21
784	13.56	79.50	10.80	9.64	10.35	0.38	0.15
1 180	13.79	76.08	10.40	10.91	10.02	0.31	2.60
1 330	13.22	77.54	10.40	11.33	9.92	0.45	0.76
1 315	13.45	76.80	10.40	11.12	9.97	0 98	0.68
1 336	12.74	73.29	9.30	13.57	11.26	0.46	1.32
1 682	13.45	78.31	10.50	11.39	9.12	0.57	0.50
1 498	13.08	75.86	9.90	12.48	10.17	0.52	0.97
1 311	12.97	78.51	10.14	11.84	8.64	0.37	0.66
1 452	12.97	78.41	10.17	12.03	8.74	0.50	0.32
1 385	12.97	78.46	10.15	11.95	8.70	0.44	0.48
1 659	12.83	78.24	10.06	10.94	9.29	1.31	0.21
1 707	12.86	78.77	10.20	11.19	8.40	1.14	0.54
1 684	12.84	78.52	10.13	11.07	8.82	1.22	0.34
1 883	12.98	80.20	10.41	10.31	8.62	0.52	0.35
1 836	12.16	79.03	9.63	10.90	8.95	0.75	0.37
1 873	12.58	79.64	10.09	10.59	8.78	0.63	0.35
2 027	12.95	80.48	10.41	10.30	8.21	0.58	0.47
1 928	12.83	78.46	10.08	11.16	8.98	0.64	0.70
1 980	12.89	79.47	10.26	10.73	8.60	0.61	0.58
1 936	13.56	77.73	10.44	9.83	10.53	0.87	0.96
1 756	12.27	76.12	10.52	9.34	11.24	0.90	0.90
1 846	12.91	76.92	10.48	9.58	10.88	0.78	0.93
1 812	12.79	76.36	9.78	10.56	11.56	0.78	0.69
1 587	12.49	69.98	8.66	13.37	11.21	0.96	4.38
1 690	12.62	72.58	9.16	11.72	11.34	0.88	3.48
1 294	11.63	66.70	7.75	17.80	13.24	1.12	1.14
1 497	12.62	65.29	8.24	14.26	13.07	0.80	6.58
1 388	12.11	65.75	7.96	16.01	13.16	0.96	4.12
1 412	12.17	69.10	8.41	15.45	13.64	1.15	0.66
1 529	12.70	71.26	9.05	14.72	10.63	1.02	2.45
1 472	12.41	70.18	8.73	15.03	12.06	1.13	1.60
1 262	11.56	69.29	8.03	14.71	12.02	1.38	2.60
1 615	12.29	78.76	9.68	9.85	9.85	0.65	0.89
1 445	11.95	74.56	8.91	12.05	10.88	1.00	1.51

1 534	13.15	76.80	10.11	10.04	11.63	0.61	0.84
1 546	13.11	77.23	10.07	10.20	8.32	0.55	3.70
1 540	13.13	77.20	10.09	10.12	9.97	0.58	2.27
1 085	12.46	73.01	9.09	10.52	9.15	0.79	6.53
727	12.46	56.75	7.07	14.22	11.67	1.46	15.90
951	12.46	67.13	8.36	11.76	10.06	1.03	9.92
1 213	12.44	63.78	7.96	8.20	9.16	0.96	17.69
954	12.28	66.54	8.17	9.77	8.71	0.73	14.25
1 091	12.37	65.24	8.07	8.83	9.00	0.87	15.95
1 000	11.85	66.00	7.82	13.16	10.97	1.08	8.79
1 035	13.12	61.74	8.10	17.00	11.28	0.99	8.99
1 018	12.49	63.73	7.96	15.21	11.13	1.04	8.89

14	1 Period	8/6/76-11/10/76	125	1 899 601	191 730	15 197
1976-77	2 Period	7/12/76-26/3/77	110	1 715 008	170 151	15 559
	Combined		235	3 614 609	361 881	15 310
15	1 Period	28/5/77-16/10/77	142	1 674 664	154 110	11 793
1977-78	2 Period	9/1/78-8/4/78	93	948 938	67 685	10 203
	Combined		233	2 623 602	221 795	11 260
16	1 Period	6/6/78-16/10/78	133	1 985 343	161 344	15 040
1978-79	2 Period	17/12/78-13/4/79	118	1 383 200	112 656	11 720
	Combined		251	3 368 761	274 000	13 420
17	1 Period	5/7/79-24/10/79	112	1 402 800	112 066	12 525
1979-80	2 Period	30/12/79-21/4/80	114	1 430 336	118 016	12 554
	Combined		226	2 833 136	230 082	12 536